Things of science

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MULTI-LAYER WOOD UNIT

No. 147

MULTI-LAYER WOOD UNIT

This unit of THINGS of science consists of five specimens, five museum-type cards and this explanatory leaflet.

Thin layers of wood are being used in a wide variety of ways. Because of the beauty of the grain, paper-thin sheets of wood backed with fabric are employed like wallpaper. Because of its strength, a layer of hardwood is sandwiched between heavy kraft paper to make a low-cost, sturdy material. Plywood is sometimes faced with a thin sheet of metal to produce a stronger, more versatile product. And layers of wood chips, held together with plastic and molded into thin sheets, are bonded together to make one of the newest members of the plywood family.

Now identify the specimens in this unit of THINGS of science, matching them with their museum-type cards:

WOOD-CHIP PLYWOOD — Core of wood chips faced with layers of resin-impregnated wood flakes (pattern of wood flakes plainly visible).

PLYWOOD FACED WITH METAL — Aluminum facing, making a more versatile material.

PAPER WITH WOOD — Hardwood sandwiched between heavy sheets of kraft paper for added strength.

WOOD ON FABRIC—Thin, flexible sheet of wood bonded to cloth.

UREA RESIN GLUE—Easy-to-prepare glue, typical of glues used for house interiors and furniture (packet of Weldwood glue).

The specimens in this unit of THINGS of science come to you through the courtesy of the United States Plywood Corp. They are sold under the trade names of Novoply (wood-chip plywood), Armorply (plywood with metal facing), Tekwood (hardwood veneer faced with kraft paper), Flexwood (thin sheet of wood on cloth) and Weldwood glue.

PLYWOOD FROM CHIPS, FLAKES

Experiment 1. Do you like the pattern of your wood-chip plywood? The intriguing design is due to numerous small shavings or flakes of wood glued together. Now turn your specimen on end and notice that it is composed of three layers. The core is of medium-sized chips while much thinner flakes compose the outside layers.

To make your specimen, the flakes for

the surface layers and chips for the core were first coated and impregnated with urea resin glue. They were next pressed under heat to form panels of the desired thickness. The core and the surface layers were laminated together under heat and pressure to make your sturdy material, $\frac{3}{8}$ inch thick.

Novoply, first announced a year or so ago, is cheaper than decorative plywood or good quality lumber. The shavings used for the outside layers are made from virgin timber undamaged by grinding or other mechanical handling. They were cut from small-sized timber not usable for lumber or plywood. Wood chips left from other fabrication jobs were used for the core. Novoply cores such as that of your specimen or cores of $\frac{3}{4}$ inch thickness are also proving excellent for mounting wood veneers or plastic sheets.

Experiment 2. Run your finger across a face of your specimen and notice how smooth the material is. Try breaking it with your hands to test its strength. Feel how light-weight it is. A piece as thick as your specimen and a foot square would weigh about $1\frac{1}{4}$ pounds.

Experiment 3. To show how tough this material is, test its resistance to a

strong blow as compared with the impact resistance of regular plywood, such as that on the reverse side of your metal-faced specimen. For uniform results, from a height of two to three feet drop a heavy round object such as a billiard ball or bowling ball onto one specimen, then from the same height let the round object strike the other specimen. Or you can try striking the two specimens with a hammer, being careful to hit each with equal force. Which specimen was least dented by the blow?

Wood-chip material such as this is already finding many uses. Furniture and fixtures, cabinet and sliding doors, and wall paneling are being made of it. What other uses can you think of?

Experiment 4. Run a knife blade along the edge of your specimen and notice that it cuts just like wood. Hammer a nail into it to test how well the material holds; affix a screw to it and try to pull it out. A pull of 170 pounds is required to extract a one-inch screw from a piece as thick as yours.

Experiment 5. Run your fingernail across the surface of your specimen to see if it is easily marred. Turn it on end and with your fingernail try to mark one

of the larger chips forming the core. To prove that your specimen is harder than many woods, notice what a deep mark your fingernail leaves in such soft woods as fir.

Since many species of wood can be used for these chips and flakes, Novoply can be made in an unlimited number of natural wood tones. Or several wood species can be mixed, producing highly attractive effects. If your specimen is light in color, it was made of pine or fir; if dark, it was created from redwood.

Experiment 6. Some people prefer a high finish on their wall panels and furniture. You can give the redwood specimen a very attractive finish simply by waxing it. If your specimen is yellow-tan in color, you can use either natural or colored waxes which contain the usual wood colors. You can paint or stain it just like plywood or lumber. Or you can rub a little paint on the surface and wipe it off lightly, leaving just enough to tone the Novoply and still allow the flake appearance to show through.

Experiment 7. Stand your specimen upright in a glass or saucer containing a little water and notice how quickly the water climbs up the plywood. Examine

the edge to see that the moisture goes faster up the core than up the facing. This is because more resin is concentrated in the surface flakes than in the core chips. Soak in water for several hours to see if the material is warped by the moisture. Leave it in water for several days to see if it is badly damaged.

The individual chips, flakes and wood-bits layers are held together with a urea resin glue. This glue is water-resistant rather than waterproof so that on long exposure to moisture it tends to lose its strength. Thus Novoply is for interior use only.

FACED WITH METAL

Experiment 8. With a pair of pliers catch the metal edge of your Armorply specimen and roll it back a little so you can see the reverse side of the metal. Does some of the wood cling to the metal, indicating that the bond between the two materials is stronger than the wood itself? Notice that the metal is so thin you can push it back and forth with your fingers, but when backed with plywood it has great strength and stiffness.

Almost any sheet metal can be bonded to plywood. It is sometimes applied to only one side, sometimes to both. Usually

aluminum, zinc-coated steel or stainless steel is utilized as the facing material. Your specimen is faced with aluminum only .015 inch thick, the most general thickness of metal used in this way.

Designs, either for good looks or to discourage defacing, are sometimes embossed on the aluminum or stainless steel before they are laminated to the plywood. Stainless steel with a pebble grain, for instance, makes an excellent "doodle-proof" material for telephone booths.

Experiment 9. Examine the edges of your plywood faced with metal to discover the typical construction of a piece of three-layer plywood. Notice that the grain of the central core runs in the opposite direction from that of the other layers. It is this difference in the direction of the grain of adjacent sheets of wood that gives plywood its strength.

The plywood in your specimen is made of Douglas fir, the wood most commonly used for Armorply because of its great strength, low cost and durability. Your specimen is an industrial grade used for truck bodies, shipping containers and the like. When metal-faced plywood is to be used for kitchen equipment, laboratory furnishings and other architectural uses, a

thin hardwood veneer such as Philippine mahogany is placed between the metal facing and the usual plywood base. This hardwood veneer minimizes any tendency toward "show-through" of wood grain on the metal surface and increases its dent-resistance.

PAPER WITH WOOD

Experiment 10. Try to bend the paper-wood plywood, testing it first in one direction and then in another, to discover how strong and tough, yet flexible, the specimen is. Now look at the edge to see that it is really a thin sheet of hardwood such as birch, maple or elm coated on both sides with kraft paper.

A special kind of kraft paper called cylinder kraft was used in making your specimen. It was employed because the fibers in the paper lie mostly in one direction. When bonded to the hardwood core, the grain of the paper is placed at right angles to the grain of the wood, giving it the same basic construction as three-ply plywood. When bent along the wood grain, Tekwood is as flexible as leather; in the other direction, it is quite stiff, as you have probably already discovered.

Experiment 11. Run a pointed metal corner of your Armorply across the paper surface of your specimen and notice what a deep mark you can leave. It is the wood core beneath that permits a sharp, clear line. A pattern can be given to Tekwood as easily as to heavy fiber board and leather, typical embossing materials.

Experiment 12. Your specimen was not sawed to this particular size and shape, but many just like it were cut or stamped out at one time. If you look carefully at the wood-and-paper edge, you can tell which side was uppermost for the machine crushed the paper down slightly toward the core as it stamped out your specimen, leaving a slightly rounded corner. Notice how neatly the edges were cut. This is because the resin binding the kraft paper and hardwood core together also holds the core's fibers securely. Also the core itself is relatively thin.

Experiment 13. Heat an electric iron and as it gets warm try bending your Tekwood specimen over the iron's hot edge. If you do this carefully, you will not split the wood and yet can give your specimen a permanent bend or curve.

The material can be curved with or against the grain of the hardwood core.

Experiment 14. With the blade of a knife cut a straight line across one face of the paper-wood plywood. Working along this same line, cut deeper and deeper through the paper and into the wood. Bend until the wood breaks and only the second layer of paper remains attached, forming a hinge holding the two pieces together. Strong boxes are made from the material by partial die-cutting and folding along the hinge.

Tekwood is used for a wide variety of purposes, ranging from decorative boxes and waste baskets, games, doll houses and other toys, to shipping containers, advertising displays, luggage and automobile interior panels. Look around you for ways in which it is used. Over 30,000,000 square feet of this material were employed during 1952.

FLEXIBLE WOOD

Experiment 15. Notice that if you work with the grain, you can roll your wood-on-fabric specimen into a cylinder without harming it. A glance at the edge shows how very thin the sheet of wood is, only 1/85 of an inch. The wood is

mounted on cotton sheeting with a water-resistant adhesive. This is done under heat and hydraulic pressure such as that used in making plywood. It is then put through flexing rolls to produce a limp, pliable sheet.

Many square yards of Flexwood can be made from one log of rare wood. A wall covered with it gives the appearance of a paneled room. The material can easily be glued to dry plaster, steel, plywood, hard wallboard, tile or marble. Because it is genuine wood, it takes any wood finish.

Experiment 16. Notice the attractive grain of your wood. Are there alternate bands of dark and light wood, showing the yearly growth of the wood? Can you spot the little growth cells of the wood? Are they arranged in neat, uniform rows like soldiers on parade, or are they staggered like rocks in a stone wall? If they are in rows, you have a softwood or "nonporous" wood; if they are staggered, you have a hardwood or "porous" wood.

Experiment 17. Press your fingernail into the wood veneer to see how easily you can leave a mark. Is it hardwood or softwood? Did you identify it correctly in the previous experiment? On

the reverse side of your specimen is stamped the species of the wood used in making your Flexwood. If marked teak, it was grown in Burma or Siam. If English oak, it was grown in England. Satinwood, used for fine furniture, comes from the East Indies. Primavera, a moderately hard and heavy wood, comes from Central America. The flat cut mahogany grew in Central America, while the ribbon mahogany came from Africa. Avodire is the name given a tropical African wood of the mahogany family, while sapeli, often used as a mahogany substitute, is not true mahogany but does belong to the same family. Korina is the trade name given a medium-hard wood grown in the Belgium Congo.

WOOD GLUE

The urea resin glue contained in this kit is similar to that used in making plywood destined for use as fine furniture or house interiors. Phenolic resin glue is used for exterior plywood and for boats as it withstands water well, but it stains light-colored woods such as oak and maple, and spoils their beauty.

Basically plywood is made pretty much the way it was manufactured sev-

eral decades ago, with the grain of each layer placed at right angles to that next to it. The chief differences today are in the bonding glues used and the hot presses employed. Sheets of wood a quarter of an inch thick now are bonded together in five minutes, sheets three-quarters of an inch thick become plywood in nine minutes. Melamine resins are being employed more and more for decorative plywood because they provide non-staining durability.

Most of the plywood made today, however, is held together with glue made either of urea-formaldehyde resin or phenol-formaldehyde resin. These are both based on synthetic resins and are known simply as urea resin glue and phenolic resin glue.

Urea, a modern and valuable fertilizer, is the first step in making the urea resin glue. This is mixed with a water solution of formaldehyde, a preservative. After proper heating, the urea and formaldehyde combine to form a syrupy solution which can then be used directly as a glue. Or it can be spray dried for more convenient handling, in which case it must first be remixed with water. Weld-

wood glue is an example of the dried material.

To make the phenolic resin glue, phenol, more commonly known as carbolic acid, is mixed with the same water solution of formaldehyde and treated in much the same manner as the urea resin glue. Again a syrupy solution is formed, but this one is amber in color. As before, the material may be used in the syrupy form or it may be spray dried.

The big difference between the two resins, other than the difference in color, is that the phenol-formaldehyde molecule is very resistant to destruction by heat, water or weathering. The urea-formaldehyde molecule is less resistant. Thus, the phenolics are used for exterior exposure or other extreme services, and the ureas are used for interior work.

Both resin glues require substances known as catalysts which speed the chemical reaction of curing. These catalysts are generally mixed in just before use. In special cases like Weldwood glue, however, the catalyst is present in the dry powder and cannot act until water is added. Thus the hobbyist and home woodworker can get good results without having to bother with two separate ingredients.

Experiment 18. Prepare your Weldwood glue according to the directions printed on the packet. Notice how easily the glue dissolves in the small quantity of water specified. Test the effectiveness of this home-mixed glue by sticking together two tongue depressors, other available pieces of wood, or some of your specimens. Coat one surface evenly and completely, squeeze them tightly together and leave overnight beneath several heavy books. Do the two then stick tightly together? Before the home-mixed glue dries out, glue together two more pieces of wood, let set under ample pressure for at least four hours. After 48 hours curing time, leave in water overnight along with your metal-plywood specimen. Which comes apart the more easily, your two pieces of wood or the plywood? Is there much difference in the tenacity of the two?

Experiment 19. If your furniture needs a home repair job, stick it back together with the glue you have just mixed. If the wood has been glued before, sand away the old glue so you have fresh wood for the joint. Best results are obtained when you clamp the wood together for a minimum of four hours.

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PAPER WITH WOOD

Hardwood sandwiched between heavy sheets of kraft paper for added strength

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PLYWOOD FACED WITH METAL

Aluminum facing, making a more versatile material

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Easy-to-prepare glue, typical of glues used for house interiors and furniture

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WOOD ON FABRIC

Thin, flexible sheet of wood bonded to cloth

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WOOD-CHIP PLYWOOD

Core of wood chips faced with layers of resin-impregnated wood flakes

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